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RATES OF PREDATION BY *CHRYSOMYA RUFIFACIES* (MACQUART) ON *COCHLIOMYIA MACELLARIA* (FABR.) (DIPTERA: CALLIPHORIDAE) IN THE LABORATORY: EFFECT OF PREDATOR AND PREY DEVELOPMENT

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Abstract.—*Chrysomya rufifacies* (Macquart) is a blow fly that was recently introduced to North America. Because the larvae of this species are facultative predators on other maggots, native North American carrion flies probably will be negatively affected by the invasion. *Cochliomyia macellaria* (Fabr.), the native calliphorid with the greatest bionomic similarity to the invader, was selected as the prey species for a laboratory study of predatory behavior. We investigated the influence of both predator and prey development on predation rates when single predators and prey were paired in the laboratory. Third instar *C. rufifacies* consumed third and, at a lesser rate, second instar *C. macellaria*. Earlier instars were not predaceous. Both relatively small and relatively large third instar *C. rufifacies* consumed the same number of mid-size prey.

Key Words.—Insecta, Calliphoridae, *Chrysomya* invasion, predatory behavior, *Cochliomyia* prey, effect of development

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The Old World blow fly *Chrysomya rufifacies* (Macquart) was apparently introduced to Costa Rica around 1978 (Jirón 1979). Since that time it has been collected in Baja California and Caifornia (Greenberg 1988), Texas (Richard & Ahrens 1983), and Arizona (Baumgartner 1986). *Chrysomya rufifacies* is an important parasite of newborn calves in extremely wet areas of Hawaii (Shishido & Hardy 1969) and concern has been expressed about the economic impact of this species in its new range (Schmidt & Kunz 1985). *Chrysomya rufifacies* larvae are facultative predators on other maggots including parasitic species (Fuller 1934). Because of this habit, and because *C. rufifacies* is typically a secondary invader of both carrion and live mammals (Fuller 1934, Norris 1959), the net economic effect of this fly is often unclear.

Carrion arthropod species display a continuous succession in a carcass (Schoenly & Reed 1987). Two species occupying the same carcass may avoid particular interactions simply because the necessary developmental stages do not meet. It is of interest, then, to know what interactions are possible between various life stages. Both second and third instar *Chrysomya rufifacies* have been described as predaceous (Goodbrod & Goff 1990), but the relative behavior of the different instars and the size of the prey that can be subdued have not been reported. As part of a study of the ecology of this fly and its impact on native Diptera, we investigated the effect of both predator and prey development on *C. rufifacies* predation rates in a laboratory setting. The prey species was *Cochliomyia macellaria* (Fabr.), the North American fly with the greatest bionomic similarity to the invader (Nicholson 1934, James 1947, Hall 1948, Bohart & Gressitt 1951, Denno & Cothran 1975, unpublished data), and presumably its closest ecological homolog.

Methods and Materials

Experiment 1.—Single *C. rufifacies* and *C. macellaria* larvae were confined together in 55 × 13 mm plastic petri dishes lined with moistened filter paper. Dishes were placed on a laboratory bench at 23° C with lights on. Larvae from laboratory colonies had been reared on an excess of ground beef. Treatments were the nine possible combinations of the three larval instars of each species. Approximate body lengths of the larvae used were 2.3, 7.4 and 10.5 mm for first, second and third instar *C. rufifacies,* and 2.3, 7.0 and 16.8 mm for first, second, and third instar *C. macellaria.* Twenty pairs were created for each treatment. The dishes were simultaneously arranged in a random pattern within 20 rows and nine columns. The larvae were constantly scanned for 5 h and instances of successful predation (*C. macellaria* consumed) by *C. rufifacies* were recorded for every hour (*C. rufifacies* curls around and pierces its prey which struggles violently in response). Following this, the larvae were left in place with the lights off for 17 h and again examined for evidence of predation.

Experiment 2.—Larvae were confined as in experiment 1, but in this case we examined the effect of predator size when third instar *C. rufifacies* attack third instar *C. macellaria.* Predator size was either relatively small (approx. 10.5 mm) or relatively large (approx. 16.2 mm) matched with one prey size (approx. 12.5 mm). Care was taken that post-feeding larvae were not used for the larger predators. Again, 20 dishes for each treatment were set up and arranged at random within a pattern of 10 rows and four columns. Because the great majority of predaceous acts in experiment 1 occurred within the first hour (see below), the larvae were constantly scanned for 1 h and instances of predation were recorded for each 0.5 h.

Results and Discussion

The numbers of dishes with predation in experiment 1 were 17 of the paired third instars, seven of third instar *C. rufifacies* with second instar *C. macellaria,* and zero for all other treatments. All acts of predation between third instars occurred within the first hour, but some from the second treatment occurred in hours two (two dishes) and three (one dish). After the dishes were left overnight in darkness a second instar *C. rufifacies* was observed feeding on a dead second instar *C. macellaria.* This may have been either predation or scavenging. In experiment 2 there was no difference in the number of prey taken by small versus large *C. rufifacies* (15 each).

The conditions in this investigation were, of course, highly artificial and might not represent true predation rates within a carcass. Still, the relative differences in behavior seen here may exist in the field. Although second instar *C. rufifacies* may be predaceous as reported, they were much less so than third instars.

Chrysomya rufifacies typically behaves as a secondary fly in that oviposition occurs on carcasses already occupied by other larvae (Fuller 1934, Bohart & Gressitt 1951, Early & Goff 1986). Our results suggest that an ecological refuge exists for native Diptera that reach the post-feeding stage before third instar *C. rufifacies* are present. We have found that all *C. rufifacies* instars are present in goat carcasses when the food is exhausted (unpublished data), indicating that no similar refuge could exist for species following *C. rufifacies* in succession.

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